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Coastal Zone  
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W.P.

# LEWES CCD PILOT STUDY

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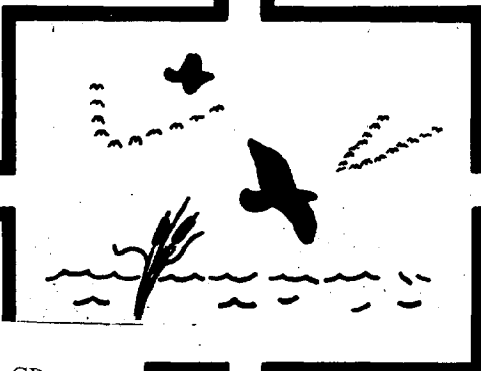
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## SOILS AND THEIR IMPLICATIONS FOR DEVELOPMENT

MARCH 1976

COASTAL ZONE  
INFORMATION CENTER

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## INTRODUCTION

Any effort to guide urban and rural development at the state, county, or local level of government in the public interest must recognize the existence of a limited natural resource base to which both urban and rural development must be adjusted if serious environmental and developmental problems are to be avoided. This is particularly true in the Lewes-Rehoboth area where an increasing number of urbanites are becoming year-round residents of outlying areas, seeking not only the varied recreational opportunities offered by these areas but also the feeling of open space, which these areas lend to urban development.

The soil resources of an area are one of the most important elements of the natural resource base, influencing both urban and rural development. Much that is of importance to mankind takes place in the soil; and soil is, directly or indirectly, the foothold for much of the life on earth. It is the natural medium for the growth of plants; its properties and life serve to stabilize wastes and purify water; it serves as the foundation for buildings, roads, and all other man-made land-based structures.

Soils are an irreplaceable resource; and mounting development pressures upon land are making this resource more and more valuable. The soil resource has been subject to misuse through improper land use and transportation facility development. Such misuse has often led to severe environmental problems, which are very expensive to correct, and to the deterioration and ultimate destruction of the resource base itself. To avoid further misuse of this important element of the natural resource base, then, it is necessary to acquire definitive data about this element and then to utilize such data to the greatest extent possible in guiding both urban and rural development.

In 1968, the State Planning Office negotiated a cooperative agreement with the Soil Conservation Service for the completion of a detailed soil survey for Sussex County, together with the provision of interpretations for planning and engineering purposes. The work was completed in 1971 and published in 1974. The purpose of this report is to assist local governmental officials and citizens in becoming familiar with the soil survey and its various applications in local planning and development programs in order that further misuse of soil resources of the county can be avoided.

Soil scientists made this survey to learn what kinds of soil are in Sussex County, where they are located, and how they can be used. They observed the steepness, length, and shape of slopes; the size and speed of streams; the kinds of native plants or crops; and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons in a soil; it extends from the surface down into the parent material that has not been changed

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much by leaching or by the action of plant roots.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs.

While a soil survey is in progress, soil scientists take soil samples needed for laboratory measurements and for engineering tests. Laboratory data from the same kind of soil in other places are also assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kind of soil. Yields under defined management are estimated for all the soils.

Soil scientists observe how soils behave when used as a growing medium for native and cultivated plants and as material, foundations, or covering for structures. They relate this behavior to properties of the soils. For example, they observe that filter fields for onsite disposal of sewage fail on a given kind of soil, and they relate this to slow permeability or a high water table. They see that streets and pavement crack on a given kind of soil, and they relate this failure to frost action. Thus, they use observation and knowledge of soil properties, together with available research data, to predict the limitations or suitability of a soil for present and potential uses.

The soil survey is designed to give the alternative uses for each kind of soil and to predict the outcome of these uses under alternative practices. These alternatives are for the consideration and decision of individuals and local planning agencies.

Community planning commonly proceeds along two different but interrelated lines: First, a general soil map shows the areas where most of the land tracts are suitable for certain uses, structures, or combinations of them; and second, the detailed soil map in the soil survey is a guide to specific operations for the individual tracts. This does not mean that the soil survey can be followed blindly. Even a detailed soil map has limitations of scale. Because of these limitations, a mapping unit of one kind of soil may include tiny areas of a different kind. The text with the soil map explains the

potentials and the hazards, but the soil survey does not eliminate the need for onsite study for the best design and location within a small tract for a building or for a sewage filter field. Then, too, although soil examinations are normally made to a depth of 5 or 6 feet, deeper material beneath the soil may influence some kinds of construction or other soil uses.

#### INTERPRETATION OF SOIL SURVEY DATA

Urban development requires planning and engineering programs designed to guide and shape urbanization in the public interest and thereby to avoid costly developmental and environmental problems. In turn, these planning and engineering programs require not only detailed information on the physical, chemical, and biological properties of the soils but also analyses of the suitability of such soils for residential, commercial, industrial, recreational, transportation, and other urban land uses, as well as for agricultural, conservation and other rural land uses.

Interpretive ratings are usually written in terms of limitations for use. This is because there are few soil limitations that cannot be overcome if the user is willing and able to pay the cost of the measures necessary to overcome the limitations.

The various interpretive analyses available to users of the soil survey are presented and discussed below. There are four general groups of interpretive analyses that contain useful information for soil survey users. These four groups are:

1. Interpretations for engineering purposes, such as the chemical and physical properties of soils, water management characteristics of soils, and the limitations of soils for road construction and other specific engineering applications.
2. Interpretations for planning purposes, such as the limitations of soils for residential development with or without public sanitary sewer service; for light industrial and commercial buildings; and for highway, railroad, and airport location.
3. Interpretations for agricultural purposes, such as the limitations of soils for cultivated crops, pasture and woodlands; the capability of soils for irrigation and drainage; and estimates of cropland and woodland yields.
4. Interpretations for aesthetic and recreational purposes, such as the limitations of soils for wildlife habitat or the maintenance of greens, shade trees, and ornamental shrubs.

The system used in rating soils for specific uses or characteristics consists of three degrees of "limitations": slight, moderate, and severe. These are discussed below in order to clarify the range of each.

### SLIGHT LIMITATIONS

A slight limitation means that the soil may be safely used for the specified purpose with only normal care in construction or installation and in maintenance.

### MODERATE LIMITATIONS

A moderate limitation means that the soil may be used for a specified purpose, but use will commonly be accompanied by some difficulties that can be prevented or overcome by relatively easy special planning, special treatment, or both.

### SEVERE LIMITATIONS

A severe limitation for a particular use does not necessarily mean that the soil cannot be put to that use, but it would require extensive and costly measures in order to overcome the limitations. In fact, the limitations for these areas are usually so severe that it is presently not economical or feasible to correct them.

### SOIL INTERPRETATIONS FOR PLANNING PURPOSES

Almost all soil properties and their limitations for various urban and rural uses are of substantial interest to regional and local planning agencies engaged in comprehensive planning for the physical development of new urban areas and for the conservation of natural resources. Particularly tailored to the regional and local planners' needs are the limitations of soils for certain urban and rural uses given in Table 1. The degree of limitation reflects the most significant single limitation, but more than one kind of limitation may be listed. For example, a soil may have a moderate limitation for a certain use because of both a moderately high water table and slope. A soil may have a moderate limitation for a certain use because of permeability, but a steeper soil of the same series may have a severe limitation because of slope alone.

Following are the soil properties that affect the uses specified in Table 1.

Disposal fields for septic-tank systems.--Permeability, depth to seasonal high water table, natural drainage, slope, and hazard of flooding or ponding.

Sites for sewage lagoons.-- Permeability, slope and hazard of flooding or ponding.

Foundations for houses of three stories or less, without basements.-- Depth to water table, natural drainage, stability of the soil slope, and hazard of flooding or ponding. For larger or heavier buildings, a special investigation should be made at each site.

Foundations for houses with basements.-- Depth to water table, natural drainage, stability of the subsoil (especially when wet), slope and hazard of flooding or ponding.

Streets and parking lots.-- Depth to water table, stability, slope and hazard of ponding or flooding.

Sites for sanitary land fills.-- Permeability, depth to water table, natural drainage, slope, hazard of flooding or ponding, and plastic properties. For trench-type landfills deeper than 5 or 6 feet, onsite studies are needed of the underlying strata, the water table, and the hazards of aquifer and ground water pollution.

Home gardens and landscaping.-- Available moisture capacity, natural fertility, depth to water table, natural drainage, texture of the surface layer, slope, degree of erosion, and hazard of flooding or ponding.

#### RESIDENTIAL DEVELOPMENT WITH PUBLIC SANITARY SEWER

Figure 1 shows those soils recommended by Soil Conservation Service to be left in their natural state. All of these soils are subject to severe flood hazards. Included in this category are coastal beach sands, tidal and fresh water marshes, floodplains and muck. In addition to flooding, most of these soils have stability or bearing strength problems that require expensive measures, such as pilings, for structural support. Slab construction or similar techniques used on filled marsh or coastal sand often suffer foundation settlement problems. Complete foundation failure resulting from flowing water across coastal beaches is a common occurrence with conventional techniques.

Figure 2 shows those upland soils with severe limitations for development. This category includes those soils that have severe wetness or ponding problems. Buildings constructed on these soils will suffer wet basements or accessibility limitations. The land surrounding a home built on soils with a high water table is often useless during the wet season. Moreover, soils of this type often have foundation problems and excavations are unstable. The wet conditions severely limit the use of construction equipment and access by automobile.

The combination of Figures 1 and 2 show those soils within the study area that, despite the provision of public utilities, have severe limitations for residential or other development. Most of the soils in this category border directly on Delaware and Rehoboth Bays or their estuaries and the Atlantic Shore. The remainder are associated with the headwaters of most streams or are located in poorly drained areas on the northern side of Rehoboth Bay and in the west-central portion of the CCD.

The extension of public utilities into or near these areas must be considered carefully, because development pressures will eventually create hardships for future residents. On the other

TABLE 1  
LIMITATIONS OF SOILS FOR RESIDENTIAL AND RELATED USES

Soil Series and Map Symbols	Degree and Kind of Limitation for—					
	Foundations for Houses of Three Stories or Less—			Streets and Parking Lots		
	Disposal Field For Septic-tank Systems	Sewage Lagoons <sup>1</sup>	Without Basements	With Basements	Trench Method	Area Method
Berryland: Bd	Severe: high water table. <sup>3</sup>	Severe: rapid permeability. <sup>3</sup>	Severe: high water table.	Severe: high water table.	Very severe: high water table; very poor drainage. <sup>3</sup>	Severe: high water table; very poor traffic capability when wet. <sup>3</sup>
Borrow pits: Bo. No interpretations. Material too variable.						
Coastal beach and dune land: Co.	Severe: fluctuating water table; tidal flooding. <sup>3</sup>	Very severe: rapid permeability; tidal flooding. <sup>3</sup>	Severe: fluctuating water table; tidal flooding; poor stability; storm hazard.	Severe: fluctuating water table; tidal flooding; poor stability; storm hazard.	Very severe: rapid permeability; tidal flooding. <sup>3</sup>	Very severe: rapid permeability; tidal flooding. <sup>3</sup>
Elkton: El, Em	Severe: high water table; slow permeability.	Slight	Severe: high water table.	Severe: high water table.	Very severe: high water table; poor drainage; plastic subsoil.	Severe: high water table; poor drainage; plastic subsoil.
Evesboro: EoB	Slight/Severe <sup>2</sup>	Severe: rapid permea- bility. <sup>3</sup>	Slight	Slight	Severe: loose; caving; rapid permeability. <sup>3</sup>	Severe: rapid permea- bility. <sup>3</sup>
EoD, EsD	Moderate: 5 to 15 percent slope. <sup>3</sup>	Severe: rapid permea- bility; 5 to 15 percent slope.	Moderate: 5 to 15 percent slope.	Moderate: 5 to 15 percent slope.	Severe: loose; caving; rapid permeability. <sup>3</sup>	Severe: rapid permea- bility. <sup>3</sup>
Eva	Slight/Severe <sup>2</sup>	Severe: rapid permea- bility. <sup>3</sup>	Slight	Slight	Severe: rapid permea- bility. <sup>3</sup>	Severe: rapid permea- bility. <sup>3</sup>
EvB	Slight/Severe <sup>2</sup>	Severe: rapid permea- bility. <sup>3</sup>	Slight	Slight	Severe: rapid permea- bility. <sup>3</sup>	Severe: rapid permea- bility. <sup>3</sup>
Fallsington: Fa, Fs	Severe: high water table.	Moderate: moderate permeability.	Severe: high water table.	Severe: high water table.	Very severe: high water table.	Severe: high water table.
Fill land: Ft. No interpretations. Material too variable.						
Johnston: Jo	Severe: high water table; flood hazard. <sup>3</sup>	Severe: flood hazard. <sup>3</sup>	Severe: high water table; flood hazard.	Very severe: high water table; flood hazard.	Very severe: high water table; flood hazard. <sup>3</sup>	Very severe: high water table; flood hazard. <sup>3</sup>
Kalmia: Ka	Slight	Moderate: moderate permeability.	Slight	Slight	Slight	Slight

See footnotes at end of table.

TABLE 1 (continued)

Soil Series and Map Symbols	Degree and Kind of Limitation for—					Sites for Sanitary Landfills		
	Foundations for Houses of Three Stories or Less—							
	Disposal Field For Septic-tank Systems	Sewage Lagoons <sup>1</sup>	Without Basements	With Basements	Streets and Parking Lots	Trench Method	Area Method	
Keanansville: KbA	Slight/Severe <sup>2</sup>	Severe: rapid permeability; <sup>3</sup>	Slight	Slight	Slight	Severe: rapid permeability; <sup>3</sup>	Severe: rapid permeability; <sup>3</sup>	Severe: rapid permeability; <sup>3</sup>
	Slight/Severe <sup>2</sup>	Severe: rapid permeability; <sup>3</sup>			Moderate: 2 to 5 percent slope.	Severe: rapid permeability; <sup>3</sup>	Severe: rapid permeability; <sup>3</sup>	Severe: rapid permeability; <sup>3</sup>
Keyport: KfA	Severe: slow permeability; moderately high water table.	Slight	Slight	Moderate: moderately high water table.	Moderate: moderately high water table.	Severe: moderately high water table.	Moderate: moderately high water table.	Moderate: moderately high water table.
	Severe: slow permeability; moderately high water table.	Moderate: 2 to 5 percent slope.	Slight	Moderate: moderately high water table.	Moderate: moderately high water table.	Severe: moderately high water table.	Moderate: moderately high water table.	Moderate: moderately high water table.
Klaj: Kl	Moderate: moderately high water table; <sup>3</sup>	Severe: rapid permeability; <sup>3</sup>	Slight	Moderate: moderately high water table.	Moderate: moderately high water table.	Severe: rapid permeability; <sup>3</sup>	Severe: rapid permeability; moderately high water table; <sup>3</sup>	Severe: rapid permeability; moderately high water table; <sup>3</sup>
Matawan: Mm	Severe: slow permeability; moderately high water table.	Slight	Slight	Moderate: moderately high water table.	Moderate: moderately high water table.	Severe: moderately high water table.	Moderate: moderately high water table.	Moderate: moderately high water table.
	Severe: slow permeability; moderately high water table.	Slight	Slight	Moderate: moderately high water table.	Moderate: moderately high water table.	Severe: moderately high water table.	Moderate: moderately high water table.	Moderate: moderately high water table.
Muck, shallow: Mu	Very severe: high water table; ponding; <sup>3</sup>	Very severe: organic material; ponding; <sup>3</sup>	Very severe: high water table; ponding; organic material; no stability when wet.	Very severe: high water table; ponding; no stability when wet.	Very severe: high water table; ponding; organic material; no stability when wet.	Very severe: high water table; ponding; <sup>3</sup>	Very severe: high water table; ponding; <sup>3</sup>	Very severe: high water table; ponding; <sup>3</sup>
	Severe: high water table; <sup>3</sup>	Severe: rapid permeability; <sup>3</sup>	Severe: high water table.	Severe: high water table; wet excavations unstable.	Severe: high water table.	Very severe: high water table; ponding; <sup>3</sup>	Severe: high water table; rapid permeability; <sup>3</sup>	Severe: high water table; rapid permeability; <sup>3</sup>
Pocomoke: Pm	Severe: high water table.	Moderate: moderate permeability.	Severe: high water table.	Severe: high water table.	Severe: high water table.	Very severe: high water table.	Severe: high water table.	Severe: high water table.
Portsmouth: Pt	Severe: high water table.	Moderate: moderate permeability.	Severe: high water table.	Severe: high water table.	Severe: high water table.	Very severe: high water table.	Severe: high water table.	Severe: high water table.
Rumford: RuA	Slight/Severe <sup>2</sup>	Severe: rapid permeability; <sup>3</sup>	Slight	Slight	Slight	Severe: rapid permeability; <sup>3</sup>	Severe: rapid permeability; <sup>3</sup>	Severe: rapid permeability; <sup>3</sup>
	Slight/Severe <sup>2</sup>	Severe: rapid permeability; <sup>3</sup>	Slight	Slight	Moderate: 2 to 5 percent slope.	Severe: rapid permeability; <sup>3</sup>	Severe: rapid permeability; <sup>3</sup>	Severe: rapid permeability; <sup>3</sup>
	Slight/Severe <sup>2</sup>	Severe: rapid permeability; <sup>3</sup>	Slight	Slight	Severe: 5 to 10 percent slope.	Severe: rapid permeability; <sup>3</sup>	Severe: rapid permeability; <sup>3</sup>	Severe: rapid permeability; <sup>3</sup>

See footnotes at end of table.



TABLE 1 (continued)

Soil Series and Map Symbols	Degree and Kind of Limitation for—					
	Foundations for Houses of Three Stories or Less—			Streets and Parking Lots		
	Disposal Field For Septic-tank Systems	Sewage Lagoons <sup>1</sup>	Without Basements	With Basements	Trench Method	Area Method
Rutledge: Ry	Severe: high water table. <sup>3</sup>	Severe: rapid permea- bility. <sup>3</sup>	Severe: high water table.	Severe: high water table; wet excava- tions unstable.	Very severe: high water table; rapid permea- bility. <sup>3</sup>	Severe: high water table; rapid permeability. <sup>3</sup>
Sassafras:						
SaA, SFA	Slight	Moderate: moderate permeability.	Slight	Slight	Slight	Slight
SaB, SFB	Slight	Moderate: moderate permeability; 2 to 5 percent slope.	Slight	Slight	Slight	Slight
SaC2	Slight	Severe: 5 to 10 percent slope.	Slight	Slight	Slight	Slight
SaD	Moderate: 10 to 15 percent slope.	Severe: 10 to 15 per- cent slope.	Moderate: 10 to 15 percent slope.	Moderate: 10 to 15 percent slope.	Moderate: 10 to 15 percent slope.	Moderate: 10 to 15 percent slope.
Swamp: Sw	Very severe: ponding.	Very severe: ponding.	Very severe: ponding.	Very severe: ponding.	Very severe: ponding.	Very severe: ponding.
Tidal marsh: Tf, Tm	Very severe: tidal flooding.	Very severe: tidal flooding.	Very severe: tidal flooding.	Very severe: tidal flooding.	Very severe: tidal flooding.	Very severe: tidal flooding.
Woodstown: Wo, Ws	Moderate: moderately high water table.	Moderate: moderate permeability.	Slight	Moderate: moderately high water table.	Severe: moderately high water table.	Moderate: moderately high water table.

<sup>1</sup> It is assumed that any surface layer or other horizon that contains appreciable amounts of organic matter will be removed and that the floor of the lagoon will be constructed on the least permeable layer in the profile. If it is constructed on a more permeable layer, the limitation will be greater.

<sup>2</sup> The slight limitation shown here is merely a rating of the ability of the soil to carry away septic tank effluent. The use of these soils for septic tanks would present only minor problems at very low, rural densities as long as wells or streams are not located nearby. The use of these soils for subdivisions, however, presents severe problems with regard to pollution of nearby wells, springs, ponds, streams or other sources of water.

<sup>3</sup> Probability of polluting nearby wells, springs, ponds, streams, or other sources of water.

hand, if these hazards are recognized, utility extensions into these areas may not be cost effective due to the limited development potential of the land.

Figure 3, conversely, shows those areas that are suitable for development with provision of public services, such as central sewer and water. The soils shown here are those rated as having slight limitations for houses without basements. Some of these soils have moderate limitations for houses with basements, due to minor water table problems, but they can be overcome, as long as they are recognized and properly dealt with.

#### RESIDENTIAL DEVELOPMENT WITH ON SITE SOIL ABSORPTION SEWAGE DISPOSAL

The successful use of the soil for on-site absorption sewerage systems is dependent on the ability of the soil to remove harmful substances and transmit sewage effluent. The relative amelioration of substances harmful to human and animal life by reduction of bacteria and filtering is the basis for determining the limitations of soils for septic tank filter fields. Until recently the operation of septic tanks and septic tank filter fields was considered successful if the soil transmitted effluent away from the soil surface. With increased use of septic tanks in lieu of public sewerage systems in many urban expansion areas or in resort areas near bays and streams, it has been found that rapid passage of sewage effluent through the soil contributes to pollution of ground water. Conversely, very slow movement of effluent through the soil will result in saturation of the soil. The effluent ponds on the soil surface or flows across it and eventually enters and pollutes surface waters. In either event, the presence of effluent on the surface of the soil causes a public nuisance and is hazardous to the public health. The danger of ground water contamination where sandy, rapidly permeable soils are used for septic tank filter fields is recognized as a severe limitation for residential subdivisions or commercial establishments. This is particularly important where housing concentrations using septic systems also obtain their drinking water from on-side or nearby shallow wells. A case in point is the Coverdale Crossroads area near Millsboro, where nitrate and bacteriological contamination of drinking water has been measured.

Slow or very slow permeability is also considered a severe or very severe limitation because most households produce more effluent than this kind of soil can transmit. The moderate and moderately rapid permeability classes impose a slight limitation for sewage disposal because effluent is transmitted rapidly enough to prevent

surface flow but slow enough to remove harmful substances by filtering. This is not always the case, however, when large concentrations of houses are involved. In the Moores Lake area of Kent County there is a group of about 100 homes on half-acre lots. These homes are located on Sassafras soils which are rated as having slight limitations for septic systems. There is no public water system, so they must depend upon individual on-site shallow wells located in the same geologic horizon as the septic tank tile fields. Well water sampling was conducted by the State in 1971 as a result of reports that nitrate concentrations double and treble the drinking water limits had been recorded by private laboratories. The State confirmed these findings and noted that higher nitrate concentrations were found downslope topographically and hydrologically from the lower concentrations. Furthermore, it is very likely that the concentration of nitrate in ground water from wells constructed in permeable sands overlain by Sassafras and similarly well-drained soils is cyclic and dependent upon an absence of diluting rainfall during the summer dry period when the downward percolation of rain water is least and water tables fall (June through August). Any ground water withdrawn by means of wells is simply returned to the water table after use by means of the septic system, thus, constantly building up the nitrate concentration. An additional hypothesis to be made regarding the contamination of water supplies in areas where soils and underlying sediments are very permeable is that pesticides, herbicides, fungicides and fertilizers applied to lawns and plants, particularly in the vicinity of shallow wells, could pose an even greater health threat than the nitrates.

The State study concluded that the practice of constructing wells and septic tanks in the same geologic horizon, regardless of the Soil Conservation Service septic tank rating, should be abandoned, particularly in crowded urban and suburban areas. Moreover, it was concluded that the percolation test alone did not seem to be adequate for evaluating the effectiveness of septic tank systems.

Figure 4 is a map depicting soils with a high potential for ground water contamination from the disposal of solid or liquid wastes. Soils in Classification I are those with very high water tables. Septic tanks located in these areas will not function during most of the year because the tile field is usually below the water surface. Since there is no place for the effluent to drain, it rises to the surface and ponds or runs off into the nearest stream. Such conditions create hardships for homeowners as well and they are often required to pump their septic tanks out every few weeks. Moreover, such conditions create pressures for the extension of public sewer and water systems, often over great distances and expense to the general taxpayer. Prohibition of on-site sewage disposal systems in such areas would be more prudent, but to date few efforts have been made to do this.

Soils in Classification II present a more serious problem because they pass the percolation test; the widely used method to determine the soil's ability to drain septic tank effluent. In these areas, however, the percolation test is not adequate, because the soils are too permeable. Effluent, therefore, is passed relatively unfiltered into the ground water and creates contamination problems. The location of septic tank developments in these areas will also generate personal and public hardships. Furthermore, depending upon the extent of the contamination, it may take years or even decades for the polluted water to be purged from the ground. In the meantime this ground water is unavailable for public or private supply.

Scattered houses at rural densities would not pose any serious problems as long as wells were located at a proper distance from the septic tank to provide for effluent dilution or drilled to a much deeper geologic strata. Subdivisions using on-site disposal systems should be prohibited on these soils.

Floodplain and marsh soils (not shown in Figure 4) are also unsuitable for septic tanks due to slow permeability and high water table. Enterprising developers and misinformed public officials often believe that by simple filling, low-lying wetlands can be made suitable for soil absorption sewage disposal systems. This is a dangerous misconception, however. The most common practice for development in marshland in Sussex County is lagoon construction, where dredge spoil derived from the lagoons is placed on the marsh surface to create fast land. The dredged material is usually the same type of soil and possesses the same poor drainage characteristics as the marsh itself. Septic systems installed under these conditions are almost certain to fail. In other instances "clean fill" is brought in from another area and used to create fast land. The problem of a poorly permeable subsoil remains, however, and effluent will either rise to the surface or flow laterally into the surface water. (For further information on the adverse effects of filling, see Working Paper #9).

Some land developers also suggest larger lots when the capability of a soil to handle sewage effluent is questionable. Larger lots, however, will not in themselves ensure the proper operation of soil absorption sewage disposal systems if the soils covering the lots are unsuited to the proper operation of the system. Often, "solutions", such as filling and larger lot sizes, are only temporary in nature since the basic problem of poor permeability or high water table remains and causes systems to fail after a relatively short period of operation. Rather than attempting to seek ways to make soil absorption disposal systems temporarily operable in such areas, local public officials should seek to prevent the installation of systems on unsuitable soils and encourage future urban growth to take place in such areas only if public sanitary sewer service can be provided.

## LANDFILLS

One method of solid waste disposal is the sanitary landfill. It is defined as a method of disposing of refuse on land without creating nuisances or hazards to public health or safety by utilizing the principles of engineering to confine the refuse to the smallest practical volume, and to cover it with a layer of earth at the conclusion of each day's operation, or at such more frequent intervals as may be necessary.

Ideally, the sanitary landfill should conform to four basic requirements. These are:

1. The lowest point of the excavation should be twenty to thirty feet above the shallowest aquifer (water-bearing zone) at the high water point during the wet season.

The site should not be subject to flooding.

2. The site should be located in slowly permeable material, such as clay.

3. Refuse should be compacted and covered daily with at least 6 inches of medium-textured material. This soil, or other suitable material, should be as impermeable as possible and should not crack on drying.

4. The site should be geologically and geographically isolated from water wells, lakes, streams or any other body of water.

These, of course, are the requirements for the ideal Sanitary Landfill. In more cases than not, however, it is impossible to find a site that fulfills them all.

The entire surface area of Delaware's Coastal Plain is considered a source of aquifer recharge, and the surface streams which originate on the Coastal Plain depend upon aquifer-supplied groundwater for 75-90 percent of their flow. Obviously, any material that is put onto the surface or into the soil must be examined for possible pollution dangers to one of Delaware's most abundant natural resources, its groundwater. Once an aquifer is contaminated, it is often difficult or impossible to restore its purity.

Until recently, an evaluation of geologic and hydrologic conditions was rarely included among the various considerations that determined site selection for landfills in Delaware. Thus, one environmental hazard created by past refuse disposal practices

is the possible effect on ground water quality. Existing landfills or dumps invariably were placed on land that had little or no value for other uses. The site chosen was located, for example, in a marshland or an abandoned sand and gravel pit, each of which is a favorable environment for the development of ground-water contamination problems.

Landfills in the region are receiving a wide variety of materials including paper products, food wastes, septic-tank sludge, demolition debris, tires, automobiles, leaves, plastics, textiles, glass, aluminum cans, liquid chemicals, oils and hydrocarbons, street sweepings, dead animals, and water and waste-water treatment sludge. In municipal refuse, paper and paper products make up the major category by weight.

The processes that can lead to contamination of ground water from the disposal of wastes in landfills are relatively simple. The various organic compounds in refuse (with the exception of most plastics) are decomposed or stabilized by aerobic and anaerobic organisms to simple substances that will decompose no further. These products of decomposition include gases and soluble organic and inorganic compounds. If sufficient water is available from precipitation, or from surface drainage in contact with the refuse, these compounds can be dissolved and carried with the water that infiltrates the landfill and ultimately recharges the ground-water reservoir or discharges into adjacent surface-water bodies.

Solid inorganic refuse, such as tin cans and metal pipes, can also be slowly dissolved by percolating waters, resulting in a solution with an increased concentration of metallic ions. Finally, disposal of liquid industrial wastes, septic-tank pumpings, and waste-water treatment sludges, can contribute to an overall increase in dissolved solids concentration of water passing through the landfill. The term "leachate" has been applied to highly contaminated water contained in or directly associated with a refuse disposal site.

The concentration of chemical and biological pollutants travelling through soil decreases with distance from the landfill. The effectiveness, however, of such processes as adsorption, ion exchange, dispersion, or dilution varies considerably with the type of pollutant involved, the characteristics of the soil underlying the landfill, and geologic and hydrologic conditions at the site. Thus, no broad generalizations can be made.

The volume of leachate developed by any particular landfill is a function of its absorptive capacity and areal extent, and the amount of recharge water available for infiltration. Most landfills assume a relatively flat surface with no vegetation, which is more conducive to infiltration than to runoff and evapotranspiration (a combination of surface evaporation and the removal of soil moisture by plants). They are normally covered with a relatively coarse-grained material, again increasing infiltration efficiency. Therefore, it is reasonable to assume

that at least one-half of the annual precipitation can become recharge to the ground-water reservoir, after it has come in contact with the solid waste contained in the landfill. Average annual rainfall in the region is 42 inches per year. Thus, a 100-acre site would be capable of producing 57 million gallons of leachate per year after field capacity of the refuse has been reached.

Research on the question of how long after abandonment a landfill can be expected to generate leachate has been minimal. However, one investigation under a grant from the U.S. Public Health Service to the Pennsylvania Department of Health sheds some light on this question. A study was made of a landfill in southeastern Pennsylvania, part of which had been closed in 1950 but was still producing leachate.

In 1972 geology students at the University of Delaware conducted a survey of landfill practices at nine locations in Delaware, five of which were in Sussex County. The study found leachate seepage at all sites and concluded that there was imminent danger of groundwater pollution at each site observed due to the high water table levels and permeable nature of the Coastal Plain soils in which they are located.

The most serious example of leachate contamination of groundwater in Delaware is occurring in New Castle County near Llangollen. Between 1960 and 1968 solid waste was deposited in an old sand and gravel pit near the intersection of Routes 40 and 13. Apparently unknown at the time, the landfill was located on the outcrop of the Potomac aquifer, northern Delaware's most important source of groundwater. Water moving through the aquifer came in contact with the bottom of the landfill. This and precipitation percolating through the waste created large volumes of contaminated water which first appeared in a domestic well south of the landfill in 1972.

During the 1960's major wells were developed in this aquifer approximately 3,000 to 4,000 feet south and east of the landfill by Artesian Water Company and Amoco Chemical Corp. Without prompt action, the leachate would have reached these wells and contaminated them. This would have resulted in loss of the most productive aquifer in the State--capable of producing 6.5 million gallons per day.

A counter pumping program close to the landfill to remove the contaminants and reverse the direction of contaminant movement away from the well field was initiated. The polluted water is now being discharged directly into Army Creek.

Eventually, the entire landfill will be removed to a site specially designed to accept the waste. The cost will be between six and eight million dollars.

As a result of this experience Delaware now has regulations governing landfill practices and designed to eliminate potential

leachate problems so that situations like this do not occur again.

Figure 4 shows those soils especially unsuited for landfills.

#### PRIME AGRICULTURAL LAND

Soil surveys can be used as a guide to the suitability of soils for cropland, the kind of crops the soils can support, and the management needed to maintain their productivity from year to year. To simplify the information being collected and to promote understanding of soil problems, a system of land capability groupings was devised. The system is based on the limitations of soils for use as cropland. Yield information and woodland suitability groupings also aid in determining the best agricultural use for soils. Drainage and irrigation guides are helpful in solving problems of excess water or inadequate water supply.

#### CAPABILITY GROUPS OF SOILS

The soils of Sussex County have been classified into capability groupings that indicate their general suitability for most kinds of farming. These are practical groupings based on limitations of the soils, the risk of damage when they are used, and the way they respond to treatment. In this system all soils are grouped at three levels: the capability class, subclass, and unit. The eight capability classes in the broadest grouping are designed by roman numerals I through VIII. In Class I are the soils that have few limitations, the widest range of use, and the least risk of damage when used. The soils in the other classes have progressively greater natural limitations. In Class VII are soils and land forms so wet, sandy or otherwise limited that they do not produce economically worthwhile yields of crops, forage, or wood products.

The subclasses indicate major kinds of limitations within the classes. Within most classes there are up to three subclasses. The subclass is indicated by the addition of a lower case letter, e, w, or s, to the class numeral, for example, IIe. The letter "e" indicates that the main limitation to the use of the soil for cultivated crops is risk of erosion; "w" indicates that water in or on the soil will interfere with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); and, "s" indicates that use of the soil for cultivated crops is restricted because it is shallow, droughty, stony or has some other soil induced limitation.

Each subclass is further divided into capability units. These consist of groups of soils that are very similar and, therefore, suited to the same kind of crop and pasture plants, require similar management, and have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping of soils for management purposes. Capability units are identified by the addition of an arabic numeral code



to the class and subclass code, for example, IIe-1 or IIIe-2.

Soils are classified in capability classes, subclasses and units in accordance with the degree and kind of their permanent limitations, but without consideration of major and generally expensive land-forming practices that would change the slope, depth or other characteristics of the soil and without consideration of possible but unlikely major reclamation projects. Most of the deep, well-drained, moderately permeable loamy soils are classified as Class I where they are nearly level. Sloping soils are susceptible to erosion because of runoff. The erosion hazard is primarily related to steepness of slope, and the soils are classed accordingly. Slowly permeable and very slowly permeable soils generally restrict root growth and are poorly aerated in the lower part of the soil. This restriction is considered a soil or "s" factor. Other soils have low available water capacity and are subject to wind erosion or droughtiness. Most wet soils with high water tables have neither an erosion hazard nor available water deficiency, but the excess water deprives plant roots of oxygen.

The eight classes in the capability system and the subclasses and units in Sussex County are described in the list that follows. The units are not numbered consecutively within the subclasses, because they fit into a Statewide system of capability classification and not all the capability units in the State are represented in this county.

CLASS I: Soils have few limitations that restrict their use (no subclasses)

Capability unit I-4. Deep, well-drained, moderately permeable, nearly level soils that have a loam surface layer and a high available moisture capacity.

Capability unit I-5. Deep, well-drained, moderately permeable, nearly level soils that have a sandy loam surface layer and a moderate to high available moisture capacity.

CLASS II: Soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Subclass IIe: Soils subject to moderate erosion unless protected.

Capability unit IIe-4. Deep, well-drained, moderately permeable, gently sloping soils that have a loam surface layer and a high available moisture capacity.

Capability unit IIe-5. Deep, well-drained, moderately permeable, gently sloping soils, that have a sandy loam surface layer and a high available moisture capacity.

Subclass IIw: Soils moderately limited because of excess water.

Capability unit IIw-1. Moderately well drained, moderately permeable, nearly level soils that have a loam surface layer and a high available moisture capacity.

Capability unit IIw-5. Moderately well drained, moderately permeable, nearly level soils that have a sandy loam surface layer and a high available moisture capacity.

Capability unit IIw-9. Moderately well drained, slowly permeable, nearly level soils that have a fine sandy loam surface layer and a high available moisture capacity.

Capability unit IIw-10. Moderately well drained, slowly permeable, nearly level soils that have a thick sandy loam surface layer and a high available moisture capacity.

Subclass IIs: Soils moderately limited by droughtiness.

Capability unit IIs-4. Deep, well drained to somewhat excessively drained, moderately rapidly permeable, nearly level and gently sloping soils that have a loamy sand surface layer and a low to moderate available moisture capacity.

Capability unit IIs-5. Deep, moderately well drained to well drained, slowly permeable, nearly level soils that have a thick loamy sand surface layer and a moderate available moisture capacity.

CLASS III: Soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.

Subclass IIIe: Soils subject to severe erosion if they are cultivated and not protected.

Capability unit IIIe-5. Deep, well drained, moderately permeable, moderately sloping, eroded soils that have a sandy loam surface layer and a high available moisture capacity.

Capability unit IIIe-33. Deep, somewhat excessively drained, rapidly permeable, moderately sloping soils that have a loamy sand surface layer and a low to moderate available moisture capacity.

Subclass IIIw: Soils severely limited for cultivation because of excess water.

Capability unit IIIw-6. Poorly drained and very poorly drained, moderately permeable soils that have a sandy loam surface layer and a moderate to high available moisture capacity.

Capability unit IIIw-7. Poorly drained and very poorly drained, moderately permeable soils that have a loam surface layer and a moderate to high available moisture capacity.

Capability unit IIIw-9. Poorly drained, slowly permeable soils that have a sandy loam surface layer and a high available moisture capacity.

Capability unit IIIw-10. Moderately well drained to somewhat poorly drained, rapidly permeable soils that have a loamy sand surface layer and a low available moisture capacity.

Capability unit IIIw-11. Poorly drained, slowly permeable soils that have a loam surface layer and a high available moisture capacity.

Subclass IIIs: Soils severely limited for cultivation by droughtiness.

Capability unit IIIs-1. Excessively drained, rapidly permeable, nearly level and gently sloping soils that have a loamy sand surface layer and a low available moisture capacity, but have a moisture-retarding layer at some depth.

CLASS IV: Soils have very severe limitations that reduce the choice of plants, require very careful management, or both.

Subclass IVe: Soils subject to very severe erosion if they are cultivated and not protected.

Capability unit IVe-5. Deep, well drained, moderately permeable, strongly sloping soils that have a sandy loam surface layer and high available moisture capacity.

Capability unit IVe-9. Moderately well drained, slowly permeable, gently sloping, eroded soils that have a fine sandy loam surface layer and a high available moisture capacity.

Subclass IVw: Soils very severely limited by excess wetness.

Capability unit IVw-6. Poorly drained and very poorly drained, moderately rapidly permeable to

to rapidly permeable soils that have a surface layer of loamy sand and a low to very low available moisture capacity.

Capability unit IVw-7. Very poorly drained, organic soils that are subject to ponding.

CLASS V: Soils are not likely to erode but have other limitations, impractical to remove, that limit their use largely to pasture, woodland, or wildlife. (None in Sussex County.)

CLASS VI: Soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture, woodland, or wildlife. (None in Sussex County.)

CLASS VII: Soils that have very severe limitations that make them unsuited to cultivation and that restrict their use largely to pasture, woodland, or wildlife.

Subclass VIIw: Soils very severely limited by excess water.

Capability unit VIIw-1. Very poorly drained soils on flood plains and very wet, unclassified soils materials, more or less continually flooded or ponded.

Subclass VIIs: Soils very severely limited by low available moisture capacity, stones, or other soil features.

Capability unit VIIs-1. Excessively drained, rapidly permeable, gently sloping to strongly sloping soils that have a loamy sand and sand surface layer and a very low available moisture capacity.

CLASS VIII: Soils and landforms have limitations that preclude their use for commercial crop production and restrict their use to recreation, wildlife, or water supply, or to use for esthetic purposes.

Subclass VIIIw: Extremely wet, marshy land.

Capability unit VIIIw-1. Marsh lands that are subject to tidal flooding.

Subclass VIIIs: Stony land, coastal beaches, and other areas that have little potential for commercial crop production.

Capability unit VIIIs-2. Loose, incoherent sands of beaches and dunes.

Capability unit VIIIs-4. Land where large amounts of soil material have been removed.

Table 2 shows the agricultural capability rating for soils in Sussex County. It is apparent that both actual and potential prime farmland may be recognized. Actual prime farmland is land with qualities that permit it to be used for farming with no special treatment other than clearing of trees, or seedbed preparation. Sussex County lands in this category fall into capability groups I and IIe and are noted in Table 2. Potential prime farmland, in contrast, is not prime in its natural condition. This is usually because it is too wet or too dry. To move it to the prime class requires expensive and sometimes difficult alteration of soil climate by providing irrigation or drainage. Potential prime farmlands in need of drainage are in capability groups IIw-1, IIw-5, IIIw-6, IIIw-7, and IIIw-10. Those in need of irrigation are in capability groups IIs-4 and IIIs. Figure 5 shows the areal extent of natural and potential prime agricultural land in the Lewes CCD.

If one compares the prime agricultural lands (Fig. 5) with the lands suitable for development (Fig. 3) it is apparent that the best soils for food and fiber production and also good for housing and other types of urban use. Gradually other uses have preempted substantial areas of farmland, because farming rarely, if ever, withstands the economic pressure that can be applied by its competitors in the land market.

These soils maps provide the basis upon which local decision makers can evaluate the urban expansion consequences that result from utility location and design and their effects on agricultural land preservation.

#### SUMMARY

Serious health, safety, and pollution problems may be caused by failure to take the capabilities and limitations of soils into consideration during the planning stage of any urban or rural development proposal. Such problems are usually very costly to correct and may create personal hardship out of all proportion to the relatively simple steps required to avoid them.

Such problems include malfunctioning on-site soil absorption sewage disposal (septic tank) systems, flood damages, footing and foundation failures, soil erosion and sedimentation, and land fill leachate. Moreover, corrections of these problems, once they occur, may entail great public, as well as private expense and may cause personal aggravation and inconvenience. Knowledge of the soil resource and its ability to sustain development can not only help in avoiding such problems, but can also contribute to avoiding or reducing excessive land development costs.

TABLE 2  
AGRICULTURAL CAPABILITY

Map Symbol	Mapping Unit	Capability Unit (Symbol)
Bd	Berryland loamy sand	IVw-6
Bo	Borrow pits	VIIIs-4
Co	Coastal beach and dune land	VIIIs-2
El	Elkton sandy loam	IIIw-11
Em	Elkton loam	IIIw-9
EoB	Evesboro sand, 0 to 5 percent slopes	VIIIs-1
EoD	Evesboro sand, 5 to 15 percent slopes	VIIIs-1
EsD	Evesboro loamy sand, 5 to 15 percent slopes	VIIIs-1
EvA	Evesboro loamy sand, loamy substratum, 0 to 2 percent slopes	IIIs-1(I)
EvB	Evesboro loamy sand, loamy substratum, 2 to 5 percent slopes	IIIs-1(I)
Fa	Fallsington sandy loam	IIIw-6(D)
Fs	Fallsington loam	IIIw-7(D)
Ft	Fill land	----
Jo	Johnston silt loam	VIIw-1
Ka	Kalmia sandy loam	I-5(N)
KbA	Kenansville loamy sand, 0 to 2 percent slopes	IIs-4(I)
KbB	Kenansville loamy sand, 2 to 5 percent slopes	IIs-4(I)
KfA	Keyport fine sandy loam, 0 to 2 percent slopes	IIw-9
KfB2	Keyport fine sandy loam, 2 to 5 percent slopes, eroded	IVe-9
Kl	Kleij loamy sand	IIIw-10(D)
Mn	Matawan loamy sand	IIs-5
Mn	Matawan sandy loam	IIw-10
Mu	Muck, shallow	IVw-7
Os	Osier loamy sand	IVw-6
Pm	Pocomoke sandy loam	IIIw-6(D)
Pt	Portsmouth loam	IIIw-7
RuA	Rumford loamy sand, 0 to 2 percent slopes	IIs-4(I)
RuB	Rumford loamy sand, 2 to 5 percent slopes	IIs-4(I)
RuC	Rumford loamy sand, 5 to 10 percent slopes	IIe-33
Ry	Rutledge loamy sand	IVw-6
SaA	Sassafras sandy loam, 0 to 2 percent slopes	I-5(N)
SaB	Sassafras sandy loam, 2 to 5 percent slopes	IIe-5(N)
SaC2	Sassafras sandy loam, 5 to 10 percent slopes, eroded	IIe-5
SaD	Sassafras sandy loam, 10 to 15 percent slopes	IVe-5
SfA	Sassafras loam, 0 to 2 percent slopes	I-4(N)
SfB	Sassafras loam, 2 to 5 percent slopes	IIe-4(N)
Sw	Swamp	VIIw-1
Tf	Tidal marsh, fresh	VIIIw-1
Tm	Tidal marsh, salty	VIIIw-1
Wo	Woodstown sandy loam	IIw-5(D)
Ws	Woodstown loam	IIw-1(D)

- (N) Prime agricultural land in its natural state.  
(I) Prime agricultural land with irrigation.  
(D) Prime agricultural land with drainage.

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